

December 1964

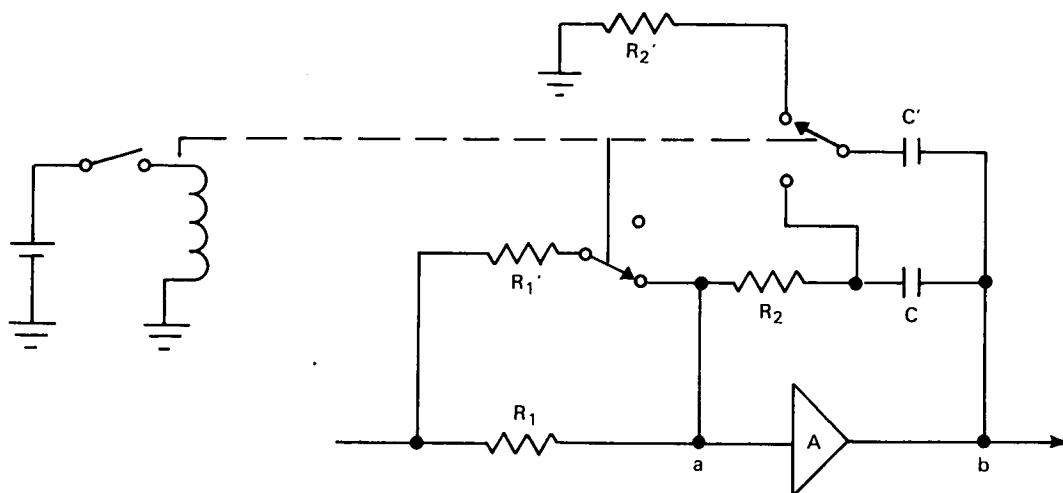
Brief 64-10349

# NASA TECH BRIEF



This NASA Tech Brief is issued by the Technology Utilization Division to acquaint industry with the technical content of an innovation derived from the space program.

## Bandwidth Switching Is Transient-Free, Avoids Loss of Loop Lock



**The problem:** Because of the speed of earth satellites, their telemetry transmission frequency at ground level is doppler shifted. Tracking equipment must have sufficient bandwidth to acquire the doppler-shifted signal. Once the signal is acquired, a narrow bandwidth about the received frequency is desired to filter out as much background noise as possible and thus increase the signal-to-noise ratio. A phase-lock loop is employed in the tracking equipment and conventional bandwidth switching uses various methods of switching capacitance. This introduces transients which, if of sufficient strength, cause loss of loop lock and requires reacquisition of the satellite's doppler-shifted nominal frequency.

**The solution:** A circuit in which no transients are introduced during bandwidth switching.

**How it's done:** The circuit shown is in the wide bandwidth mode and overcomes transient-producing

capacitance switching by maintaining an equivalent voltage on  $C$  and  $C'$  at all times because point  $a$  is essentially at ground potential for the typical operational amplifier  $A$ .  $R_2'$  is such that the time constants  $R_2C$  and  $R_2'C'$  are also equal, further assuring equivalent voltage at all times. Thus, bandwidth switching may be done at any time with little or no transient effects, the integrity of the loop lock being thereby maintained.

Point  $b$  is, for  $A$ , of such low impedance that driving the added load  $C'R_2'$  is of no consequence so long as  $R_2'$  is of reasonable value compared to the output impedance of  $A$ .

Acquisition is easily made under initial conditions of wide bandwidth. Switching is initiated by a "signal present" detector which automatically narrows the bandwidth after acquisition, thus increasing the signal-to-noise ratio to the required value.

(continued overleaf)

**Notes:**

1. Critical circuit parameters, such as damping ratio, are not altered when bandwidth is switched.
2. A large bandwidth change can be accomplished with no disturbance to loop lock.
3. Inquiries concerning this invention may be directed to:

Technology Utilization Officer  
Western Operations Office  
150 Pico Boulevard  
Santa Monica, California, 90406  
Reference: B64-10349

**Patent status:** NASA encourages the immediate commercial use of this invention. Inquiries about obtaining rights for its commercial use may be made to NASA Headquarters, Washington, D.C., 20546.

Source: Space Technology Laboratories, Inc.  
under contract to Western Operations Office  
(WOO-054)